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FAB 26

NITROSAMINES

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Commonwealth Agricultural Bureaux, Farnham Royal, Bucks; Institut fur Dokumentationswesen, Frankfurt am Main; Institute of Food Technologists, Chicago; Centrum voor Landbouwpublikaties en Landbouwdocumentatie (Pudoc), Wageningen; Zentralstelle fur maschinelle Dokumentation– Frankfurt am Main.

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Titles of the FABs now available are given on the back cover of this ooklet. New titles are being added at the rate of about 10 per year. or up-to-date lists of FABs or suggestions for new topics please write to he address given overleaf. New subjects are searched for at least the five ost recent volumes of Food Science and Technology Abstracts. Thereafter ach FAB is updated monthly. Copies of each months abstracts on any topic ay be obtained as indicated on the back cover of this publication. At the nd of each volume of up-dating, the abstracts are merged and made available s a separate supplement to the original FAB.

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Copies of all original articles referred to in the abstracts may be bought (or occasionally borrowed) from the International Food Information Service. A form for ordering these is provided at the end of this FAB.

Coverage of the subject has been restricted to that of Food Science and Technology Abstracts, which covers over 1200 of the important food journals, patents from 20 countries and books published world-wide. Every effort is made to include all significant references, but editorial discretion is used on the many articles of borderline interest. If the reader particularly needs an exhaustive search of the subject, we will be pleased to provide any other references that we have available. We would, in any case, encourage readers to write or telephone us with any comments or queries that they may have.

H. BROOKES
ASSISTANT EDITOR

1

The reliability of a procedure for the determination of nitrosamines in food.
Goodhead, K.; Gough, T. A.
Food and Cosmetics Toxicology **13** (3) 307-312 (1975) [21 ref. En] [Lab. of the Gov. Chemist, Stamford Street, London SE1 9NQ, UK]

Investigations were carried out to assess the overall reliability of the clean-up and concn. procedures and the GLC-MS confirmation. The clean-up procedure involves steam distillation of the sample followed by solvent extraction of the distillate and concn. by evaporation. Recoveries from this procedure were estimated by the GLC separation of the individual nitrosamines and subsequent detection by a Coulson electrolytic conductivity detector. The value of the Coulson detector for screening purposes prior to mass spectrometric confirmation was assessed using cheese (60 samples), fish (33), meat (61), brine (28), seasoning (18), and flour, bread and pastry (10). In the analysis of these foodstuffs about half of the positive results obtained with the Coulson detector were shown to be false by GLC-MS, so the latter technique is essential for confirmation of nitrosamines The Coulson detector substantially reduces the work load on the MS and gives an indication of expected levels of nitrosamine. VJG

2

[Occurrence of nitrosamines in plants.] Über das Vorkommen von Nitrosaminen in pflanzlichem Material.
Dressel, J.
Landwirtschaftliche Forschung **25** (28/II Sonderheft) 273-279 (1973) [19 ref. De] [Landwirtschaftliche Versuchssta. der BASF, Limburgerhof/Pfalz, Federal Republic of Germany]

Only traces (approx. 0.02 ppm) of niro nitrosamines were detected in grains of various wheat varieties grown in hydroponics experiments in the presence of 40 ppm N/container as NH_4NO_3, $NaNO_2$ or dimethyl- or diethyl-nitrosamine. SKK

3

N-Nitrosodimethylamine in cold-smoked sablefish.
Gadbois, D. F.; Ravesi, E. M.; Lundstrom, R. C.; Maney, R. S.
Journal of Agricultural and Food Chemistry **23** (4) 665-668 (1975) [8 ref. En] [US Dept. of Commerce, Nat. Oceanic and Atmospheric Administration, Nat. Marine Fisheries Service, Northeast Util. Res. Center, Gloucester, Massachusetts 01930, USA]

Sablefish was treated with nitrite levels ranging from 0 to 1300 ppm prior to being cold smoked. The flesh was analysed for the presence of N-nitroso compounds by GLC immediately after processing and again after 2 wk storage at 40°F. Trace amounts of N-nitrosodimethylamine (<10 parts/billion) were detected in samples with nitrite levels ranging from 0 to 550 ppm. This value did not increase with higher nitrite levels. Storage at 40°F did reflect a slight decrease in concn. The identity of the isolated compound was confirmed by GLC as the nitramine derivative and by GLC-MS. AS

4

[Determination of steam-volatile N-nitrosamine in biological materials.]
Kowalski, B.
Roczniki Panstwowego Zakladu Higieny **26** (3) 375-381 (1975) [19 ref. Pl, ru, en] [Zaklad Farmkologii i Toksykologii, Inst. Weterynarii, Pulawy, Poland]

The method is based on steam-distillation, extraction with methylene chloride, purification by preparative TLC, detection and semiquantitative estimation by TLC, and final detn. by GLC with N detector. The confirmation of identity of individual N-nitrosamines was carried out by a technique based on the oxidation of N-nitrosamines to their corresponding nitramines with peroxytrifluoroacetic acid. Appropriate nitramines were determined by electron capture gas chromatography after additional purification on an Al/MgO column. The method was successfully applied to fish meal, meat, stomach content, blood and milk samples. AS

5

[Stability of nitroso derivatives (nitrosothiols, nitrosophenols, nitrosohaemoglobin) at alkaline pH.]
Cantoni, C.; Bianchi, M. A.; Beretta, G.
Industrie Alimentari **14** (7/8) 79-81 (1975) [16 ref. It, en] [Istituto di Ispezione degli Alimenti di Origine Animale, Univ. degli Studi, Milan, Italy]

Studies on the stability of nitrosocysteine, nitrosoglutathione, nitrosophenol and nitrosohaemoglobin held for ≤48 h at 5° or 37°C in tris/HCl buffer at pH 7, 7.5, 8, 8.5 or 9 are described; a table of values is given for the quantity of NO^- released from each compound at each temp. and pH studied. At 37°C, decomposition of nitrosocysteine and nitrosoglutathione occurred; pH had no clear effect on the extent of decomposition, except that decomposition of nitrosoglutathione at pH 9 was markedly greater than at the other pH studied. No decomposition of nitrosophenol or nitrosohaemoglobin was observed at 37°C, and no decomposition of any of the nitroso derivatives studied was observed at 5°C. These results are discussed in relation to decomposition of nitroso compounds in the human intestine, and consequent implications for the safety of nitrite-containing foods. AJDW

6

[Effect of ascorbic acid on the formation of N-nitrosodimethylamine in vitro.]
Kawabata, T.; Shazuki, H.; Ishibashi, T.
Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] **40** (12) 1251-1256 (1974) [9 ref. Ja, en] [Dep. of Biomed. Res. on Food, Nat. Inst. of Health, Shinagawa-ku, Tokyo, Japan]

7

Formation of heterocyclic N-nitrosamines from the reaction of nitrite and selected primary diamines and amino acids.
Warthesen, J. J.; Scanlan, R. A.; Bills, D. D.; Libbey, L. M.
Journal of Agricultural and Food Chemistry **23** (5) 898-902 (1975) [33 ref. En] [Dep. of Food Sci. and Tech., Oregon State Univ., Corvallis, Oregon 97331, USA]

8

Carbonyl-amine reaction products as a possible source of nitrosatable nitrogen.
Marshall, J. T., Jr.; Dugan, L. R., Jr.
Journal of Agricultural and Food Chemistry **23** (5) 975-978 (1975) [19 ref. En] [Dep. of Food Sci. and Human Nutr., Michigan State Univ., East Lansing, Michigan 48824, USA]

The possibility of forming N-nitrosamines by reaction of sodium nitrite with compounds produced from aliphatic aldehydes and primary amines was investigated. Sodium nitrite was combined with an aldehyde-amine mixture, with imines formed by aldehyde-amine condensation, and with a model dry food system designed to promote nonenzymic browning reactions between aldehydes and amino groups. Reaction products were tested for apparent nitrosamine content with Griess reagent, and whenever possible, were characterized by bp, IR spectrophotometry, and gas chromatography-MS. N-nitrosamine formation was not demonstrated in aqueous systems containing sodium nitrite and carbonyl-amine reaction products. Extracts of meat samples to which an arbitrary excess of sodium nitrite (2.76%) had been added were analysed with gas chromatography-MS, but the presence of nitrosamines has not yet been confirmed. AS

9

Formation of dimethylnitrosamine from commercial lecithin and its components in a model system.
Pensabene, J. W.; Fiddler, W.; Doerr, R. C.; Lakritz, L.; Wasserman, A. E.
Journal of Agricultural and Food Chemistry **23** (5) 979-980 (1975) [8 ref. En] [USDA, E. Regional Res. Cent., Philadelphia, Pennsylvania 19118, USA]

The formation of dimethylnitrosamine (DMNA) from choline chloride is reported. Choline is commonly found as a component of lecithin. Since lecithin is present in animal tissue and is a widely used food additive, DMNA formation in foods containing both lecithin and nitrite is a possibility. When 4.56 mmol of various natural lecithins and their components was allowed to react with sodium nitrite at pH 5.60 under model system conditions concn. (0.70-30.76 ppm). AS

10

Variables affecting botulinum toxin development and nitrosamine formation in fermented sausages. [Lecture]
Kueper, T. V.; Trelease, R. D.
Proceedings of the Meat Industry Research Conference pp. 69-74 (1974) [En] [Swift & Co., Oak Brook, Illinois 60521, USA]

Studies on factors influencing growth and toxin formation by Clostridium botulinum, organoleptic properties, residual nitrite concn. and nitrosamine formation in fermented sausages are briefly described. Variables studied included: nitrite concn. (≤300 ppm); nitrate concn. (≤1500 ppm); fermentation temp. (50° or 90°F); inoculum level (≤10 000 spores/g); pH (5.6 or 5.2); storage conditions (≤80°F for ≤3 months); presence or absence of glucose; and use or non-use of a starter culture. Tables of results are given. The results show that: nitrite controlled toxin formation in non-fermented sausages; no toxin was formed in fermented sausages, even in the absence of nitrite; $NaNO_2$ markedly improves the flavour and appearance of fermented sausage ($NaNO_3$ also improves flavour and appearance, but to a lesser extent); nitrite disappears rapidly from fermented sausages, but is generated from nitrate during prolonged high-temp. storage. No nitrosamines were detected in any sample. [See 8 2S132.] AJDW

11

A rapid method for the determination of sub-part per billion amounts of N-nitroso compounds in foodstuffs.
Fine, D. H.; Rounbehler, D. P.; Oettinger, P. E.
Analytica Chimica Acta **78** (2) 383-389 (1975) [11 ref. En] [Thermo Electron Corp., 85 First Avenue, Waltham, Massachusetts 02154, USA]

The method, utilizing a gas chromatograph-thermal energy analyser, requires only 2 or 3 simple steps; vacuum distillation from mineral oil of the N-nitroso compounds extracted from the ground samples, extraction with dichloromethane and (depending on required sensitivity) concn. on a Kuderna Danish evaporator. Sensitivity is routinely at the 0.01-0.05 μg/kg level, and quantification of all N-nitroso compounds amenable to GLC is possible. Analyses were performed on (i) canned tuns fish, (ii) canned beef extract, (iii) soya bean oil used to deep-fry cod and potato chips, and (iv) fried bacon extract. (i) and (iv) contained 0.20 and 5.9 μg/kg dimethylnitrosamine, and 0.46 and 52.0 μg/kg N-nitrosopyrrolidine, respectively (ii) contained only 0.2 μg/kg of nitrosopiperidine and

approx. 0.1-0.6 μg/kg of unidentified nitrosamines. (iii) was shown to be free from detectable N-nitroso compounds. JRR

12

[Food plants - free amino acids and nitrosamines.]
Nahrungspflanzen - freie Aminosäuren und Nitrosamine. [Lecture]
Schwerdtfeger, E.
Qualitas Plantarum - Plant Foods for Human Nutrition **25** (1) 89-103 (1975) [56 ref. De, en] [Bundesanstalt für Ernährung, Inst. für Qualitätsforschung Pflanzlicher Erzeugnisse, D-6222 Geisenheim/Rheingau, Federal Republic of Germany]

Aspects reviewed in this paper include: increases in the free amino acid content of edible plants (fruit, vegetables, cereals) after harvest; differences between the amino acid compositions of the free and total (free + protein-bound) amino acid fractions of edible plants (with reference to tables of data for potatoes, wheat, onions and lettuce); and increases in the amine concn. in edible plants during storage (with special reference to nitrosamine formation). AJDW

13

Determination of dimethylnitrosamine and nitrosoproline by differential pulse polarography.
Chang, S. K.; Harrington, G. W.
Analytical Chemistry **47** (11) 1857-1860 (1975) [18 ref. En] [Dep. of Chem., Temple Univ., Philadelphia, Pennsylvania 19122, USA]

The usefulness of differential pulse polarography for the detn. of 2 structually different nitrosamines in various media (including methylene chloride - the last step in the extraction of nitrosamines from processed foods) was demonstrated. At pH 1.7, dimethylnitrosamine (DMN) and nitrosoproline both gave well defined peaks in separate solutions as well as in mixtures. The % eror in the detn. of DMN in the presence of varying amounts of nitrite ion was only 1.4% at a DMN:NO_2^- ratio of 1:0.1 and 7.8% at a ratio of 1:0.5. AL

14

Absence of nitroso formation from [$^{-14}$C]methomyl and sodium nitrite under simulated stomach conditions.
Han, J. C.-Y.
Journal of Agricultural and Food Chemistry **23** (5) 892-896 (1975) [7 ref. En] [Biochem. Dep., Exp. Sta., E. I. du Pont de Nemours & Co. Inc., Wilmington, Delaware 19898, USA]

15

Inhibition of N-nitrosamine formation in model food systems.
Gray, J. I.; Dugan, L. R., Jr.
Journal of Food Science **40** (5) 981-984 (1975) [33 ref. En] [Dep. of Food Sci. & Human Nutr., Michigan State Univ., E. Lansing, Michigan 48824, USA]

The effect of certain compounds, some of which are endogenous to cured meat systems and some which may be added for preservative or other purposes, on the N-nitrosation reaction was investigated in both aqueous and low moisture carboxymethylcellulose system. Essentially complete inhibition of the reaction was achieved when the ratio of ascorbic acid (or bisulphite) to nitrite was >2:1. Antioxidant compounds were also effective in blocking dimethylnitrosamine formation. The inhibiting effect of amino acids, cysteine, glutathione and methionine varied with the pH of the system. IFT

16

Failure to induce tumours in guinea-pigs after concurrent administration of nitrite and diethylamine.
Sen, N. P.; Smith, D. C.; Moodie, C. A.; Grice, H. C.
Food and Cosmetics Toxicology **13** (4) 423-425 (1975) [11 ref. En] [Health Protection Branch, Dep. of Health & Welfare, Ottawa K1A OL2, Canada]

Simultaneous administration of diethylamine hydrochloride (2 or 4 g/l.) and sodium nitrite (0.4 or 0.8 g/l.) in the drinking water to guinea-pigs for a period of ≤30 months, provides optimum conditions for the formation of diethylnitrosamine (DEN) in the stomach of the experimental animals. This treatment failed to indice any tumours in the experimental animals. When DEN (15 mg/l.) was administered in the drinking water, 18 of 20 guinea pigs developed liver tumours within 1 yr. Guinea pigs receiving only 4 g/l. amino or 0.8 g/l. nitrite did not develop liver tumours. Data therefore suggest that amount of in vivo synthesis of diethylnitrosamine in the stomachs of the animals was insufficient to induce cancer in the animals within the experimental period. VJG

17

Relative significance of dietary sources of nitrate and nitrite. [Review]
White, J. W., Jr.
Journal of Agricultural and Food Chemistry **23** (5) 886-891 (1975) [34 ref. En] [USDA, E. Regional Res. Cent., Philadelphia, Pennsylvania 19118, USA]

In order to provide some perspective on amounts of nitrate and nitrite in our diet, a calculation was made to evaluate the relative contribution of various known sources of nitrate and nitrite. Combining estimates of per capita consumption of various categories of food and drink with average values for nitrate and nitrite content of these diet components has made it possible to attribute the nitrate and nitrite intake of the average US inhabitant to major dietary categories. It is estimated that four-fifths of nitrate intake is from vegetables, and less than one-sixth from cured meats. Other sources (fruits, milk products, water, bread) are not significant. Two-thirds of the nitrate entering the average stomach originates in saliva and slightly less than one-third comes from cured meats. Other sources of nitrite are not significant. AS

18

Analysis for aqueous nitrates and nitrites and gaseous oxides of nitrogen by electron capture gas chromatography.
Ross, W. D.; Buttler, G. W.; Duffy, T. G.; Rehg, W. R.; Wininger, M. T.; Sievers, R. E.
Journal of Chromatography **112**, 719-727 (1975) [7 ref. En] [Monsanto Res. Corp., Dayton Lab., St. B Box 8, Dayton, Ohio 45407, USA]

A highly sensitive gas chromatographic method is presented for the detn. of aqueous nitrates. By suitable chemical pretreatment, this method is also applicable to the analysis of aqueous nitrites and gaseous oxides of N. The method has been applied to the analysis of drinking water, etc. The technique involves the conversion of the nitrate ion to nitrobenzene with subsequent analysis by electron capture has chromatography. The detection limit for nitrobenzene is about 10^{-12} g, making possible the analysis of environmentally significant concn. of aqueous nitrates and nitrites and gaseous oxides of N. AS

19

N-nitrosamines: absence from sauerkraut and silage.
Tate, R. L., III; Alexander, M.
Journal of Agricultural and Food Chemistry **23** (5) 896-897 (1975) [17 ref. En] [Lab. of Soil Microbiol., Dep. of Agron., Cornell Univ., Ithaca, New York 14853, USA]

Volatile N-nitrosamines were not detected in corn silage and sauerkraut prepared in the laboratory. Nitrosamines were not formed if the corn was supplemented with 250 ppm of nitrate N and the cabbage was supplemented with 250 or 1250 ppm of nitrate N prior to fermentation. Nitrosamine synthesis did occur in sauerkraut if both a secondary amine and nitrite were added. Thus, formation of volatile nitrosamines is unlikely even if the silage and sauerkraut are prepared from nitrate-rich plants. AS

20

Use of a clean-up method to improve specificity in the analysis of foodstuffs for volatile nitrosamines.
Walker, E. A.; Castegnaro, M.; Pignatelli, B.
Analyst **100** (1196) 817-821 (1975) [13 ref. En] [Unit of Environmental Carcinogens, Int. Agency for Res. on Cancer, 150 Cours Albert Thomas 69008 Lyon, France]

An adsorption chromatography system is described for the clean-up of nitrosamines extracted from foodstuffs. The method depends on an initial separation of nitrosamines into 2 fractions on an alumina column, oxidation to nitramines, and subsequent separation of the nitramines on the same type of column. By careful standardization of the procedure the nitramines are found in specific fractions of the eluate. Interference was reduced to a min. and specificity of nitrosamine detection by gas chromatography increased correspondingly. The method has been applied in a complete dietary survey covering cooked meals containing meat, fish, eggs, vegetables, herbs, bread, rice, wheat flour, fruit juices and other individual ingredients of the meals. Recoveries from samples spiked with nitrosamines were normally >60%. AL

21

Analysis for N-nitrosamines by chromatographic procedures.
Wasserman, A. E.
Abstracts of Papers, American Chemical Society **169**, ANAL 125 (1975) [En] [E. Regional Res. Cent., USDA, 600 East Mermaid Lane, Philadelphia, Pennsylvania 19118, USA]

N-nitroso compounds are, for the most part, carcinogenic in a number of animal species. Some nitrosamines have been detected in trace quantities in certain foods that are cured with nitrite, but the significance of these traces is still obscure. The determination of nitrosamines in cured meat products presents analytical problems. Analytical procedures require painstaking extraction, isolation and clean-up treatments prior to quantitation and identification. Gas chromatography, with several types of detectors, is the current method of choice for separating and quantitating nitrosamines. The detectors, alkali flame ionization, electrometric conductivity and electron capture are discussed. In spite of the clean-up procedures, contaminating materials are known to give spurious positive results and confirmation by MS is required. AS

22

Formation of C- and S-nitroso compounds and their further reactions. [Lecture]
Gilbert, J.; Knowles, M. E.; McWeeny, D. J.
Journal of the Science of Food and Agriculture **26** (11) 1785-1791 (1975) [19 ref. En] [Min. of Agric., Fisheries and Food, Food Sci. Div., Colney Lane, Norwich NR4 7UA, UK]

The possible involvement of nitrite in C- and S-nitrosation reactions with either food components or food additives is reviewed. C-nitrosation of phenols has been shown to occur in smoked bacons with the formation of trace amounts of nitrophenols, and protein-nitrite interactions have been studied under simulated stomach conditions where 3 products were identified. Also some theoretically possible reactions of nitrite with the activated methylene groups of creatinine and ketones are considered. The implication of reaction with sulphydryl groups of meat proteins with loss of nitrite in meat products and of the potential formation of S-nitrosothiols is discussed with reference to current literature. AS

23

The formation and analysis of N-nitrosamines. [Lecture]
Foreman, J. K.; Goodhead, K.
Journal of the Science of Food and Agriculture **26** (11) 1771-1783 (1975) [74 ref. En] [Lab. of the Gov. Chem., Cornwall House, Stamford Street, London SE1 9NQ, UK]

The assessment of the potential carcinogenic risk to human health of the small quantities of N-

nitrosamines formed in some foodstuffs depends on the availability of information on the routes by which they can be formed and of analytical methods having adequate sensitivity and selectivity for their determination. The present state of knowledge on these 2 aspects is reviewed in this paper. AS

24

[Toxicity and analysis of nitrosamines in food products. A bibliography.] [Review]
Lenges, J.; Vo-Thi, N. B.; Luks, D.
Revue des Fermentations et des Industries Alimentaires **29** (6) 170-181 (1974) [32 ref. Fr, nl] [Service de Tech. Alimentaire, IIF-IMC, CERIA, 1070 Brussels, Belgium]

25

Occurrence of volatile nitrosamines in spice premixes.
Gough, T. A.; Goodhead, K.
Journal of the Science of Food and Agriculture **26** (10) 1473-1478 (1975) [25 ref. En] [Lab. of the Gov. Chem., Stamford Street, London SE1 9NQ, UK]

Nitrosamines have been found in spice-curing salt premixes used in meat products. A number of premixes were analysed using gas chromatography and high resolution MS and the presence of N-nitrosopiperidine was confirmed in the majority of the premixes. After storage for 6 months, levels of N-nitrosopiperidine had increased in most instances, and N-nitrosopyrrolidine was detected in several samples. AS

26

Use of isomers in the detection and estimation of volatile nitrosamines by combined high-resolution mass spectrometry-gas chromatography.
Crathorne, B.; Edwards, M. W.; Jones, N. R.; Walters, C. L.; Woolford, G.
Journal of Chromatography **115** (1) 213-217 (1975) [9 ref. En] [British Food Manufacturing Ind. Res. Ass., Leatherhead, Surrey, UK]

27

A method for the identification and quantitation of volatile nitrosamines.
Wolfram, J. H.
Dissertation Abstracts International, B **36** (3) 1205: Order no. 75-19879 (1975) [En] [New Hampshire Univ., Durban, New Hampshire 03824, USA]

A method for detecting seven volatile N-nitrosamines at concn. of approx. 10 parts/billion is described. The method involves denitrosation with anhydrous methylene chloride containing 3% HBr; the resulting amine salts are reacted with 7-chloro-4-nitrobenzo-2-oxa-1,3-diazol, and the fluorescent derivatives are separated chromatographically and quantified spectrometrically. This method was used in studies on seafoods (mainly shellfish); recoveries of 50-80% were found, except for nitrosopyrrolidine (25-40% recovery). N-dimethylnitrosamine was found in several processed seafoods and in samples of frozen clams and mussels after extended storage. AMW

28

[The effect of temperature on the rate of decomposition of nitrites and nitrates and on the process of myoglobin conversion into nitrosomyoglobin in cured pork.]
Nevescanin, S.
Tehnologija Mesa **16** (1) 9-12 (1975) [10 ref. Sh, en] [IMK "29. novembar", Subotica, Yugoslavia]

The decomposition of $NaNO_2$ and $NaNO_3$ (injected as brine) in ham was studied after holding the hams for 48 h at 6-8°C, after pasteurization at 80°C for 60 min, and after sterilization at 110°C for 40 min. Concn. of $NaNO_2$ and $NaNO_3$ were determined, together with the % of myoglobin converted into nitrosomyoglobin. Tables of results are given. Nitrite decomposition in sterilized samples was approx. double that in pasteurized samples; nitrites were decomposed much more easily than nitrates. Nitrosomyoglobin formation increased with increasing processing temp. STI

29

Reaction of sodium nitrite with dimethylglycine produces nitrososarcosine.
Friedman, M. A.
Bulletin of Environmental Contamination and Toxicology **13** (2) 226-232 (1975) [19 ref. En] [Dep. of Pharmacology, Med. Coll. of Virginia, Health Sci. Div., Virginia Commonwealth Univ., Richmond, Virginia 23298, USA]

30

Evaluation of ascorbyl monoesters for the inhibition of nitrosopyrrolidine formation in a model system.
Pensabene, J. W.; Fiddler, W.; Feinberg, J.; Wasserman, A. E.
Journal of Food Science **41** (1) 199-200 (1976) [9 ref. En] [USDA, E. Regional Res. Cent., Philadelphia, Pennsylvania 19118, USA]

The effect of a number of ascorbic acid derivatives on the nitrosation of pyrrolidine was determined in a model system developed to simulate the lipid-aqueous-protein composition of bacon. Sodium ascorbate reduced nitrosopyrrolidine formation 43% in the aqueous phase, but had little effect in the lipid layer. The combination of several ascorbyl esters with sodium ascorbate increased the inhibitory effect to a high of 70% in the aqueous phase. In the lipid phase, up to 49% reduction in nitrosation was observed. IFT

31

The estimation of N-nitrosamines in tropical regions by reversed-phase paper and thin-layer chromatography.
Vasundhara, T. S.; Jayaraman, S.; Parihar, D. B.
Journal of Chromatography **115** (2) 535-541 (1975) [19 ref. En] [Defence Food Res. Lab., Mysore, India]

A simple and convenient procedure based on reversed-phase paper chromatography and TLC is reported for the detection and estimation of N-nitrosamines in food products, particularly cured meat. The method can easily be applied in tropical regions when plenty of sunshine is available. It is particularly useful in food-testing laboratories where sophisticated analytical instruments such as the gas chromatograph, mass spectrometer, etc., are not available. By this procedure, it is possible to detect up to 10-µg and to estimate up to 75-µg (reversed-phase) and 50-µg (thin-layer) amounts of N-nitrosamines. AS

32

[Study of nitrosamine formation.]
Raya, K. K. [Raja, K.]; Kann, Yu. M. [Kann, J.]; Tauts, O. V.; Kask, K. A.
Tallina Polütehnilise Instituudi Toimetised No. 367, 101-107 (1974) [8 ref. Ru, en]

In view of the nutritional importance of nitrosamines as potential carcinogens, model experiments on synthesis of nitrosodiethylamine and nitrosomorpholine were carried out to investigate the possible pathways of nitrosamine formation in man. SKK

33

In vivo formation of nitroso compounds. V. Formation of dimethylnitrosamine from nitrate and dimethylamine by bacteria in human saliva.
Ishiwata, H.; Tanimura, A.; Ishidate, M.
Journal of the Food Hygienic Society of Japan [Shokuhin Eisceigaku Zasshi] **16** (4) 234-239 (1975) [10 ref. En] [Nat. Inst. of Hygienic Sci., Kamiyoga 1-chome, Setagaya-ku, Tokyo, Japan]

The formation of dimethylnitrosamine (DMN) from nitrate and dimethylamine in the presence of human saliva was studied. Accumulation of DMN in a solution which contained dimethylamine hydrochloride, sodium nitrate and brain heart infusion was increased by addition of glucose. When the same solution was held in the mouth, no DMN was detected. [See preceding abstr. for part IV.] TM

34

Studies on the metabolism of dimethylnitrosamine in the rat. II. The effects of phenobarbitone and 20-methylcholanthrene on the in vitro and in vivo metabolism and acute toxicity of dimethylnitrosamine in young and mature rats.
Phillips, J. C.; Heading, C. E.; Lake, B. G.; Gangolli, S. D.; Lloyd, A. G.
Food and Cosmetics Toxicology **13** (6) 611-617 (1975) [35 ref. En] [British Ind. Biol. Res. Ass., Woodmansterne Road, Carshalton, Surrey SM5 4DS, UK]

See FSTA (1975) 7 9C319 for part I.

35

[Determination of nitrosamines in foods. II.]
Kann, Yu. M.[Kann, J.]; Tauts, O. V.; Raya, K. K.[Raja, K.]; Kask, K. A.
Tallina Polütehnilise Instituudi Toimetised No. 367, 85-93 (1974) [3 ref. Ru, de]

Total nitrosamine contents (determined using the Griesz reagent) are tabulated (µg/kg) for 10 spp. of hot-smoked sea fish (range, 2-70), 4 of fried fish (range, 1-3), 5 of fresh fish (range, 0-5), 11 samples of canned fish (range, 0-5), sun-cured fish (2), caviar (10) and cod liver (2). Proportions of nitroso dimethyl-, diethyl-, dipropyl- and dibutylamines are tabulated for 7 of the 10 spp. of hot-smoked fish. Proportion ranges of the amines in the order listed were 0-35, 13-45, 0-64, and 0-55%. [See FSTA (1975) 7 3A144 for part I.] SKK

36

Dimethylnitrosamine in souse and similar jellied cured-meat products.
Fiddler, W.; Feinberg, J. I.; Pensabene, J. W.; Williams, A. C.; Dooley, C. J.
Food and Cosmetics Toxicology **13** (6) 653-654 (1975) [19 ref. En] [E. Regional Res. Cent., Philadelphia, Pennsylvania 19118, USA]

7 samples of souse, 2 of blood and tongue, and 1 of head cheese (Mock brawn) were analysed for 6 volatile nitrosamines, namely, DMNA, methylethylnitrosamine, diethylnitrosamine, nitrosopiperidine, nitrosopyrrolidine (NPy) and nitrosomorpholine. Results showed that DMNA was present in 6 of the 7 samples of souse and in both samples of blood and tongue in concn. ranging from 3 to 63 µg/kg. The presence of NPy (19 µg/kg) in 1 sample of souse was confirmed by MS. The sample of head cheese contained no detectable nitrosamine. Residual nitrite varied in the samples from no detectable amount to 135 µg/kg, but there appeared to be no correlation between residual $NaNO_2$ content and the DMNA concn. found. The nitrosamines were determined quantitatively by GLC using an alkali flame ionization detector and the analyses were confirmed by GLC-high resolution MS. VJG

37

Rapid nitrosation of phenols and its implications for health hazards from dietary nitrites.
Challis, B. C.
Nature, UK **244** (5416) 466 (1973) [12 ref. En] [Dep. of Organic Chem., Imperial Coll., London SW7 2AY, UK]

The interaction of dietary nitrite with phenolic compounds, either in food processing or in the

digestive tract, is discussed. There is little information on the possible carcinogenicity of nitrosophenols, but if they prove to be harmless then phenolic compounds in the diet and gastric juice may effectively remove nitrite salts before they interact with secondary amines or other nitrogenous material to form carcinogenic N-nitrosamines. AL

38

[Thin-layer chromatographic methods for determination of organic N-nitroso (nitrosamine) compounds.]
Preda, N.; Popa, L.; Sendrea, D.; Galea, V.
Igiena **24** (1) 43-46 (1975) [15 ref. Ro, en, ru] [Lab. de Toxicologie, IMF Cluj-Napoca, Romania]

A method is described for the analysis of nitrosamines in meat products, based on TLC on silica gel. Two reagents are proposed: diphenylamine palladium chloride and Griess reagent. Application of the method to some meat products conditioned with nitrite and nitrate revealed nitrosamines in 30% of the products investigated. The method is recommended for analysis of nitrosamines in both meat products and in biological material. AS

39

Inhibition of nitrosamine formation in fried bacon by propyl gallate and L-ascorbyl palmitate.
Sen, N. P.; Donaldson, B.; Seaman, S.; Iyengar, J. R.; Miles, W. F.
Journal of Agricultural and Food Chemistry **24** (2) 397-401 (1976) [32 ref. En] [Food Res. Div., Health Protection Branch, Ottawa, Ontario K1A OL2, Canada]

It was shown that treatment, just prior to frying, of normal nitrite-cured bacon with 1000 ppm of propyl gallate, piperazine, sodium ascorbate, or ascorbyl palmitate markedly reduces the formation of nitrosopyrrolidine during cooking. Propyl gallate, piperazine, and ascorbyl palmitate were more effective than sodium ascorbate in this respect. When nitrosoproline was added to lard or bacon prepared without nitrite and the mixture cooked, the formation of nitrosopyrrolidine was demonstrated but the yield was extremely low (0.06-0.21%). Addition of the above-mentioned additives did not inhibit the formation of nitrosopyrrolidine from nitrosoproline. It was, therefore, concluded that these additives inhibit nitrosopyrrolidine formation in normal bacon by interfering with reactions other than the decarboxylation step of nitrosoproline. The possibility of using ascorbyl palmitate in cured bacon is discussed. AS

40

Distribution of some volatile nitrosamines in cooked bacon.
Gough, T. A.; Goodhead, K.; Walters, C. L.
Journal of the Science of Food and Agriculture **27** (2) 181-185 (1976) [11 ref. En] [Lab. of the Gov. Chem., London SE1 9NQ, UK]

Bacon was fried in the normal UK domestic manner, and the rashers, the cooked-out fat and the vapour were analysed for N-nitrosopyrrolidine and N-nitrosodimethylamine. Quantitative results were based on high resolution mass spectral measurements, and it was found that for both of the nitrosamines by far the greatest proportion occurred in the vapour. AS

41

Localised occurrence of N-nitrosopyrrolidine in fried bacon.
Patterson, R. L. S.; Taylor, A. A.; Mottram, D. S.; Gough, T. A.
Journal of the Science of Food and Agriculture **27** (3) 257-260 (1976) [15 ref. En] [Meat Res. Inst., Langford, Bristol, UK]

Experiments were carried out in which bacon rashers were fried to a final temp. of 140°C either whole or after division into lean, fat and rind. Where rashers were fried whole, similar levels of N-nitrosopyrrolidine were found in the lean, fat, rind exuded fat of individual bacon sides, although there was up to a 10-fold difference between bacon from different sides. When the lean, fat and rind were fried separately, the N-nitrosopyrrolidine was found almost exclusively in the residual fatty tissue and the exuded fat, with only just detectable quantities being found in the lean and rind of a few samples. AS

42

[Nitrosation products of creatine and creatinine in meat.] Nitrosierungsprodukte von Kreatin und Kreatinin in Fleisch.
Davidek, J.; Velisek, J.; Klein, S.; Janicek, G.
Fleischwirtschaft **56** (1) 99-100 (1976) [14 ref. De] [Inst. für Lebensmittelchemie, Chem.-Tech. Hochschule, Suchbatarova 1905, 166 28 Prague 6, Czechoslovakia]

The formation of N-nitrososarcosine from creatine and of L-methyl-hydantoin-5-oxime and creatinine-5-oxime from creatinine was studied in meat to which 1000 mg $NaNO_2$/100 g had been added. N-nitrososarcosine was determined in samples heated for up to 9 days to +30° and +100°C, and in samples heated to +30°C with 4 ml 4% acetic acid/10 g meat. Highest concn. of N-nitrososarcosine at 30°C, was 14.7 mg/100 g after 6 days; the highest concn. was 13.6 mg/100 g after 4 days, due to faster breakdown of the compound at higher temp. This breakdown was accelerated at lower pH resulting in max. concn. of 0.945 mg after 4 days at 30°C in presence of acetic acid. About 2.1 and 2.7% of creatine was transformed to N-nitrososarcosine at 30° and 100°C respectively, but no nitrososarcosine was formed at 0°C. No oximes were found, probably due to the pH of the meat (optimum pH for oxime formation in model experiments was 3.6). RM

43

Thin-layer chromatography of N-nitrosamines.
Gunatilaka, A. A. L.
Journal of Chromatography **120** (1) 229-233 (1976) [15 ref. En] [Chem. Dep., Univ. of Sri Lanka, Peradeniya Campus, Peradeniya, Sri Lanka]

A staining method is described which makes use of the facile acidic cleavage of nitrosamines to their corresponding amines, which are then detected with acidic iodoplatinate spray reagent. The high sensitivity shown by the reagent could be applied to detection of nitrosamine carcinogens in biological samples. AL

44

Nitrite, nitrosamines, and cancer.
Issenberg, P.
Federation Proceedings **35** (6) 1322-1326 (1976) [37 ref. En] [Eppley Inst. for Res. in Cancer, Univ. of Nebraska Med. Cent., Omaha, Nebraska 68105, USA]

The danger of occurrence of carcinogenic N-nitroso compounds and their precursors in foods is discussed, with reference to: the carcinogenicity of these compounds; factors influencing their formation in foods or in the digestive tract; methods for detection and detn. of these compounds; and examples of the occurrence of N-nitroso compounds in foods. AJDW

45

A survey of fish products for volatile N-nitrosamines.
Iyengar, J. R.; Panalaks, T.; Miles, W. F.; Sen, N. P.
Journal of the Science of Food and Agriculture **27** (6) 527-530 (1976) [35 ref. En] [Food Res. Lab., Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario, K1A OL2, Canada]

A study was undertaken to determine the levels of nitrate, nitrite and volatile N-nitrosamines in various fish products (halibut, salmon, cod, sole, ocean perch, scallops). The samples were analysed for 5 volatile nitrosamines, namely dimethylanitrosamine (DMN), diethylnitrosamine (DEN), dibutylnitrosamine (DBN), nitrosopyrrolidine (NPyr) and nitrosopiperidine (NPip), all of which are potent carcinogens. Both GLC (Coulson electrolytic conductivity detector, pyrolytic mode) and TLC methods were used for estimating the levels of nitrosamines. The average level of nitrate was 8 part/10^6 (range 0-94 parts/10^6), and nitrite was present in traces only. Traces of DMN (3-12 parts/10^9) were found in some uncooked (raw) fish. Increased levels of DMN (3-18 parts/10^9) and traces of DEN (4-14 parts/10^9) were observed after baking and frying, indicating formation of these compounds during cooking. None of the samples contained DBN, NPyr or NPip. In 10 of 15 samples the identities and levels of DMN and DEN were confirmed by GLC-high resolution MS. AS

46

Mass spectrometric quantification of traces of volatile N-nitrosamines in meat products.
Stephany, R. W.; Freudenthal, J.; Egmond, E.; Gramberg, L. G.; Schuller, P. L.
Journal of Agricultural and Food Chemistry **24** (3) 536-539 (1976) [21 ref. En] [Lab. for Chem. Analysis of Foodstuffs, Nat. Inst. of Public Health, Bilthoven, Netherlands]

A combined gas chromatographic-mass spectrometric method for detection and quantification of 5 volatile N-nitrosamines in meat products is described. The N-nitrosamines are isolated from spiked samples, purified, and conc. by steam distillation, dichloromethane extraction, and evaporation. The components of the resulting extract are gas chromatographically separated under isothermal conditions on both an apolar and a polar glass capillary column and detected by mass fragmentography at a resolution of approx. 4000. Recoveries from various meat products were determined for 10 and 50 µg/kg of N-nitrosamines: N-nitrosodimethylamine (70-101%), N-nitrosodiethylamine (78-99%), N-nitrosodi-n-butylamine (68-100%), N-nitrosopyrrolidine (40-62%), and N-nitrosopiperidine (78-103%). The lower detection and quantification limit of the method described appeared to be 0.1-0.2 µg/kg depending on the N-nitrosamine studied. None of the N-nitrosamines mentioned above could be detected in unfortified samples. AS

47

Rapporteurs' papers presented at the 20th European meeting of meat research workers, Dublin, September 15-20, 1974. [Conference proceedings]
Ireland, Republic of, An Foras Taluntais
Proceedings of the European Meeting of Meat Research Workers No. 20, 224pp. (1975) [many ref. En, De, Fr] Dublin, Irish Republic

The text is given of rapporteurs' papers presented at this symposium. The first section 'The stress syndrome and meat quality' consists of the following papers: Genetics, growth and development, by M. J. Clancy (pp. 1-16, 9 ref., En); Physiology, by D. Lister (pp. 17-27, 13 ref., En); Muscle biochemistry, by j. V. McLoughlin (pp. 28-32, En); and Handling, transport and slaughter, by W. Sybesma (pp. 33-37, 4 ref., En). The second section 'Nitrites and nitrosamines in processed meats' consists of the following papers: Medical aspects, by R. G. Cassens (pp. 38-48, 7 ref., En); Chemistry, by M. Ranken (pp. 49-63, 10 ref., En); Microbiology, by L. Leistner (pp. 64-91, De); and General papers on meat processing, by F. P. Niinivarra (pp. 92-107, De). The third section 'Packaging fresh and cured meat' consists of the following papers: Metabolism of meat in the package, by D. E. Hood (pp. 108-121, 13 ref., En); Quality of fresh and packaged meat, by G. Heinz (pp. 122-138, De); Changes during storage, by G. A. Gardner (pp. 139-146, 17 ref., En); and General papers on packaging, by A. A. Taylor (pp. 147-152, En). The fourth section 'Refrigeration, freezing and thawing' includes the following papers: Engineering problems - the cold chain, by T. Nilsson (pp. 153-161, En); [continued in following abstr.] AJDW

48

Some chemical studies on the nitrosamine problem with respect to bacon production. [Lecture]
Patterson, R. L. S.; Mottram, D. S.
Proceedings of the European Meeting of Meat Research Workers No. 20, 77-79 (1975) [17 ref. En, fr, de, ru] [ARC Meat Res. Inst., Langford, Bristol, UK]

Because of the possibility of nitrosamine formation during bacon manufacture, the concn. of volatile amines and nitrosamines in 10 pork M. longissimus dorsi muscles were determined at the following stages of Wiltshire-type curing: immediately after slaughter, after hanging but before curing, after maturation, and after vacuum-packed storage of the bacon. One tertiary, 2 secondary and 5 primary amines were detected in concn. ranging from 10 to 1900 µg/kg. Of the secondary amines detected, only dimethylamine (DMA) was present in significant quantity, and the mean concn. doubled from slaughter to the end of storage. No nitrosamines were found above the detection limit (1 µg/kg) in any of the uncooked pork or bacon. In laboratory experiments, simulating normal bacon curing, the conversion of added DMA to N-nitrosodimethylamine (NDMA) at pH 5.6 was in the brine and in the meat. Heating treated meat by canning or frying resulted in increased concn. of NDMA, particularly in the fried fat. The lowest nitrosamine levels were found in meat cured in the presence of ascorbate, and the min. molar ratio of ascorbate to nitrite necessary in the starting brine to obtain max. suppression of NDMA formation was concluded to be 0.5. [See FSTA (1976) **8** 10S1831.] AS

49

[Elimination of residual nitrite and nitrosamines in cooked sausage manufacture.] [Lecture]
Pal'min, V. V.; Prizenko, V. K.; Fedorova, G. A.; Loginova, O. A.
Proceedings of the European Meeting of Meat Research Workers No. 20, 94-96 (1975) [7 ref. Ru, en, de, fr] [Vses. Nauchno-issled. Inst. Myasnoi Promyshlennosti, USSR]

A method for cooked sausage manufacture is described, in which a mixture of nitrite, ascorbate and the disodium salt of haemin chloride is used as the colour developing agent. It was found that nitrosohaemochromogen may also be suitable for use as a colour developing agent. Cooked sausages made with these colour developing agents meet the requirements of Soviet standards. A method for quantitative detn. of nitrosamines in cooked sausage is also described. [See FSTA (1976) **8** 10S1831.] AS

50

Cured meats with reduced nitrite preserved by radappertization. [Lecture]
Wierbicki, E.; Heiligman, F.; Wasserman, A. E.
Proceedings of the European Meeting of Meat Research Workers No. 20, 100-102 (1975) [8 ref. En, fr, de, ru] [US Army Natick Lab., Natick, Massachusetts 01760, USA]

Studies on the nitrate and nitrite concn. required for production of ham and bacon of normal quality, and for adequate control of Clostridium botulinum in radappertized samples are briefly described. Effects of ascorbate and erythorbate were also studied. Numerous tables of values are given for organoleptic properties, composition and colour of the 100 irradiated and non-irradiated samples. Effects on colour, texture and keeping quality are discussed, together with the irradiation dose required for control of Cl. botulinum. Nitrosamine formation was also studied. No nitrosamines were detected in freshly-cured ham; nitrosopyrrolidine was detected in fried bacon and bacon drippings. Irradiation had no significant effect on nitrosamine formation. [See FSTA (1976) **8** 10S1831.]
• AJDW

51

Survey of food products for volatile N-nitrosamines.
Havery, D. C.; Kline, D. A.; Miletta, E. M.; Joe, F. L., Jr.; Fazio, T.
Journal of the Association of Official Analytical Chemists **59** (3) 540-546 (1976) [36 ref. En] [Div. of Chem. & Physics, FDA, Washington, DC 20204, USA]

A variety of food products (bacon, ham, pork products, baby foods, cheeses, fats, oils, total diets, spice-cure mixtures and Icelandic foods) containing nitrite were analysed for 14 volatile N-nitrosamines by a method demonstrated to be sensitive to 10 parts/billion. 121 food samples were screened for volatile N-nitrosamine content. N-nitrosopyrrolidine was confirmed in fried bacon at levels ≤139 parts/billion. N-dimethylnitrosamine, N-nitrosopyrrolidine, and N-nitrosopiperidine were also confirmed in spice-cure mixtures at levels ranging from 50 to 2000 parts/billion. AS

52

[The nitrosamines.]
Goded y Mur, A.
Revista Espanola de Lecheria No. 100, 79-84 (1976) [6 ref. Es]

This article discusses the chemical reaction by which nitrosamines are formed, their precursors, toxic characteristics, the types of foods in which they are found (e.g. pasteurized milk and cheeses), and methods for their detn. in dairy products, particularly the IDF method of van Ginkel. The nitrosamines are listed in a table, together with their formulae, carcinogenic characteristics, application (oral, subcutaneous or intravenous), and the main organ affected (liver, lungs, oesophagus, kidneys). ADL

53

N-nitrosamines: a review of chemical and biological properties and their estimation in foodstuffs. [Review]
Crosby, N. T.; Sawyer, R.
Advances in Food Research **22**, 1-71 (1976) [many ref. En] [Lab. of Gov. Chemist, London, UK]

This comprehensive review summarizes the chemical and biological properties of nitroso compounds, covering nitrosation and the rate of reaction; general synthetic routes to N-nitrosamines; properties and structure; chemical reactions; carcinogenicity; and biochemical changes; and discusses in detail work on analytical aspects and results obtained recently with these methods for a wide range of foods. The formation of nitroso compounds both in model systems and in vivo is considered with reference to kinetic data and toxicological techniques, and present and future research programmes are examined. 15pp. of references are given. AL

54

Null carcinogenic effect of large doses of nitrosoproline and nitrosohydroxyproline in Wistar rats.
Nixon, J. E.; Wales, J. H.; Scanlan, R. A.; Bills, D. D.; Sinnhuber, R. O.
Food and Cosmetics Toxicology **14** (2) 133-135 (1976) [17 ref. En] [Dep. of Food Sci. & Tech., Oregon State Univ., Corvallis, Oregon 97331, USA]

Large doses (totalling 290 mg/animal) of the nitrosamino acids, nitrosoproline or nitrosohydroxyproline, were given orally in 4 weekly doses to weanling rats which were then observed for their life-time. The rats were maintained on a basal semi-purified diet or a basal diet containing cyclopropenoid fatty acids. Positive controls received diethylnitrosamine and negative controls were given water. No tumorigenic effect was seen in rats given nitrosoproline or nitrosohydroxyproline. Cyclopropenoid fatty acids had no significant effect on the carcinogenicity of the nitrosamino acids. VJG

55

Dietary nitrosamines. [Review]
Cooper, P.
Food and Cosmetics Toxicology **14** (3) 205-206 (1976) [16 ref. En] [British Ind. Biol. Res. Ass., Woodmansterne Rd, Carshalton, Surrey, UK]

Recent work on dietary nitrosamines is reviewed with particular reference to sensitive analytical procedures for detection and estimation of volatile nitrosamines, addition of nitrite to spiced meat preparations, occurrence of dimethylnitrosamine in frankfurters, N-nitrosopyrrolidine in mettwurst sausages, and nitrosamines in fried bacon, fish meal and wheat. VJG

56

Formation of dimethylnitrosamine from pesticides carrying methylated tertiary amino groups in the presence of nitrite at pH 3.
Egert, G.; Greim, H.
Food and Cosmetics Toxicology **14** (3) 193-195 (1976) [18 ref. En] [Abteilung für Toxikologie, Univ. Tübingen, D-74 Tübingen, Federal Republic of Germany]

Many pesticides are secondary or tertiary amines, which are known to form nitroso compounds in the presence of nitrite under conditions resembling those in the human stomach, and so their presence with that of nitrite in human food may be a hazard to man. The interaction of 6.9 mg/ml of sodium nitrite with 2 dimethylurea derivatives, cycluron (0.19 mg/ml) and chloroxuron (0.29), one thiuram disulphide, thiram (0.24), and one phosphine compound, dimefox (0.15), was investigated by incubation for 4 h at 37°C in the presence of excess nitrite at pH 3. The reaction products were extracted with dichloromethane and were analysed qualitatively and quantitatively by IR spectrophotometry, NMR spectrometry, GLC-MS and light spectrophotometry. All 4 pesticides formed carcinogenic dimethylnitrosamine, yields being cycluron 4%, chloroxuron 3%, thiram 9% and dimefox 22%. VJG

57

Plant uptake and leaching of dimethylnitrosamine.
Dean-Raymond, D.; Alexander, M.
Nature, UK **262** (5567) 394-396 (1976) [12 ref. En] [Lab. of Soil Microbiol., Dep. of Agronomy, Cornell Univ., Ithaca, New York 14853, USA]

Experiments are reported showing that dimethylnitrosamine (DMNA) can be assimilated by the roots of lettuce and spinach, is translocated to the tops and that it also moves readily through soil. Both lettuce and spinach absorbed radioactivity from ^{14}C-DMNA, added at 0.057 or 0.57 µCi to the growth medium (sand or soil for lettuce, water medium for spinach), the amount assimulated being proportional to the ^{14}C-DMNA added. The quantity of DMNA taken up by lettuce was 14.38 and 106.0 µg/g dry wt. when grown on sand or soil respectively, when exposed for 2 day to 0.57 µCi ^{14}C-DMNA; % uptakes were 3.25 and 5.06 respectively. AL

58

Methods for limiting the content of dimethylnitrosamine in Chinese marine salt fish.
Fong, Y. Y.; Chan, W. C.
Food and Cosmetics Toxicology **14** (2) 95-98 (1976) [14 ref. En] [Dep. of Biochem., Univ. of Hong Kong, Hong Kong]

A high incidence of hepatocellular carcinoma and nasopharyngeal carcinoma has been reported among Chinese in Hong Kong. Cantonese salt fish has been implicated. Investigations were carried out to determine nitrosatable amine in 3 marine fish: red seabeam (Argyrops spinifers), golden thread (Nemipterus virgatus) and mackerel

Scomberomorus commersoni) and 3 freshwater fish: mud carp (Cirrhina molitorella), grass carp (Ctenopharyngodon idellus), and grey mullet (Mugil cephalus). Levels of nitrosatable amines were higher in the marine fish than in the freshwater fish. The level of dimethylnitrosamine (DMN) in marine fish was correspondingly higher after nitrosation with 0.145M $NaNO_2$ at pH 3. Amounts of DMN formed in marine and freshwater fish preserved with crude salt, with pure NaCl, with NaCl + $NaNO_2$ or with NaCl + $NaNO_3$ were determined. When either $NaNO_2$ or $NaNO_3$ was added at 200 ppm, the amount of DMN formed in both marine and freshwater fish was higher than when these compounds were not included. In all cases, amount of DMN formed in freshwater fish was less than that in marine fish. The amount of DMN formed in golden thread salted with added antimicrobial preservatives showed that benzoic acid was a better preservative than tetracyclines for preventing the formation of DMN. The use of various tetracyclines increased the yield of DMN in salt fish. VJG

59

[Changes of dimethylamine (DMA) content in fish muscle during heat processing.]
Ryu, B. H.; Lee, J. C.; Lee, E. H.
Bulletin of the Korean Fisheries Society **7** (3) 115-120 (1974) [10 ref. Ko, en]

Nitrosamines are formed when secondary amines and nitrite are present. Nitrites occur naturally in vegetables, fruits and many other foods, and are frequently used in fish products as a colour fixative or preservative. To investigate the formation of nitrosamines in fish meat, changes of dimethylamine (DMA) content during heat treatment such as drying and fish cake processing were studied. Results showed that DMA increased considerably during heat processing. During drying, DMA in cuttlefish increased 16 times, while in Alaska pollack it doubled compared to the fresh product. In roasted mackerel, DMA content appeared to be 6 times higher than the fresh product, but was 8 times higher on canning. In fish cake from yellow corvenia, DMA was 4 times higher than in the freshfish. Diethylamine and diphenylamine were not found in this experiment. [From En summ.] VJG

60

N-nitrosopyrrolidine collected as a volatile during heat-induced formation in nitrite-containing pork.
Warthesen, J. J.; Bills, D. D.; Scanlan, R. A.; Libbey, L. M.
Journal of Agricultural and Food Chemistry **24** (4) 892-894 (1976) [12 ref. En] [Dep. of Food Sci. & Tech., Oregon State Univ., Corvallis, Oregon 97331, USA]

Ground pork belly containing 200 ppm of sodium nitrite was heated to 177°C and the condensate was collected and analysed for N-nitrosopyrrolidine using gas chromatography and MS. Nitrosopyrrolidine in an amount equivalent to 19 parts/billion (average) in the initial ground pork sample was detected in the condensate. When the total amount of nitrosopyrrolidine in the cooked pork, rendered fat, and condensate was determined, it was found that 20-40% of the total nitrosopyrrolidine produced was given off as a volatile during the cooking process. The amount of nitrosopyrrolidine produced was increased when 0.1% putrescine was added to the ground pork prior to heating. The addition of an equal amount of proline resulted in the production of even higher levels of nitrosopyrrolidine. AS

61

Nitrites and bacon curing. [Lecture]
Schaffner, R. M.
Association of Food and Drug Officials, Quarterly Bulletin **40** (2) 129-132 (1976) [En] [Bureau of Foods, FDA, 200 C Street S.W., Washington, DC 20204, USA]

The experimental evidence concerning nitrosamine formation in bacon is briefly reviewed, and the FDA proposals on nitrite regulation are outlined. JRR

62

Dimethylnitrosamine and nitrosopyrrolidine in fumes produced during the frying of bacon.
Sen, N. P.; Seaman, S.; Miles, W. F.
Food and Cosmetics Toxicology **14** (3) 167-170 (1976) [14 ref. En] [Food Res. Div., Food Directorate, Health Protection Branch, Ottawa K1A 0L2, Canada]

Fried bacon has been consistently shown to contain dimethylnitrosamine (DMN) and nitrosopyrrolidine (NPY). Investigations were carried out to determine the amounts of these volatile nitrosamines given off in the fumes during normal cooking (100 g samples fried for 13 min in an electric frying pan at a temp. of 340-350°F or 8-10 min at 400°F) of cured bacon. Results show considerable amounts of both DMN and NPY in the fumes. Since DMN is more volatile than NPY the % loss (of the total) of DMN (average 70%) in the fumes was greater than the corresponding figure for NPY (average 50%). Treatment of the bacon with ascorbyl palmitate (approx. 160-240 mg/100 g) before cooking markedly reduced the concn. of both DMN and NPY in the fumes. A few samples of bacon fumes containing traces of diethylnitrosamine. The results were confirmed by combined GLC and high-resolution MS analysis. VJG

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14	Viscosity of Foods	□ £11.00	□ £3.00	□ £7.0
15	Taste Panels in Food Science	□ £8.00	□ £3.00	□ £8.0
16	Taints in Foods	□ £8.00	□ £3.00	□ £7.0
17	Microbial Toxins in Foods	□ £8.00	□ £3.00	□ £8.0
18	Smoked Food Products	□ £9.00	□ £3.00	□ £6.0
19	Disposal of Waste Food Products	□ £12.00	□ £5.00	□ £9.0
20	Use of Glucose in Food Products	□ £8.00	□ £3.0 0	□ £6.0
21	Emulsifiers in Foods	□ £9.00	□ £3.00	□ £7.0
22	Stabilizers in Foods	□ £9.00	□ £3.00	□ £7.0
23	Staling and Antistaling Additives	□ £8.00	□ £3.00	□ £6.0
24	Catering Industry	□ £8.00	□ £3.00	□ £6.0
25	Antioxidants	□ £9.00	□ £3.00	□ £7.0
26	Nitrosamines	□ £8.00	□ £3.00	□ £6.0
27	Content and Analysis of Mercury in Foods	□ £6.00	□ £3.00	□ £7.0
28	Content and Analysis of Lead in Foods	□ £7.00	□ £3.00	□ £6.0
29	Heatable Packs	□ £6.00	□ £3.00	□ £6.0
30	Sulphur Dioxide in Food Products	□ £8.00	□ £3.00	□ £6.0
31	Lactic Acid Bacteria in Beverages and Food	□ £11.00	□ £3.00	□ £8.0
32	Colorants	□ £9.00	□ £3.00	□ £6.0
33	Browning of Foods	□ £8.00	□ £3.00	□ £6.0
34	Aflatoxins	□ £7.00	□ £3.00	□ £7.0
35	Antibiotic Properties and Residues in Food excluding Nisin	□ £8.00	□ £3.00	□ £6.0
36	Nisin	□ £6.00	□ £3.00	□ £6.0
37	Cadmium in Foods	□ £6.00	□ £3.00	□ £6.0
38	Coffee	□ £10.00	□ £3.00	□ £7.0
39	Sorbic Acid	□ £7.00	□ £3.00	□ £6.0
40	Arsenic in Foods	□ £6.00	□ £3.00	□ £6.0
41	Ascorbic Acid	□ £5.00	□ £3.00	□ £8.0
42	Thickeners and Gelling Agents	□ £4.00	□ £3.00	□ £6.0
43	Pseudomonadaceae and Food Processing	□ £5.00	□ £3.00	□ £6.0
44	Spores in Food	□ £3.00	□ £3.00	□ £7.0
45	Breadmaking	□ £9.00	□ £3.00	□ £6.0
46	Bread Properties	□ £8.00	□ £3.00	□ £6.0
47	Food Science and Technology Books	□ £11.00	□ £6.00	□ £12.0
48	Nitrates and Nitrites in Meat Products	□ *£4.00	□ £3.00	□ £7.0
49	Eggs & Poultry Meat	□ *£8.00	□ £6.00	□ £10.0
50	Mycotoxins in Foods (Excluding Aflatoxins & Microbial Toxins)	□ £4.00	□ £3.00	□ £6.0
51	Meat Canning	□ *£4.00	□ £3.00	□ £7.0

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